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PATENT, TRADEMARK, COPYRIGHT AND RELATED INTELLECTUAL PROPERTY LAW

January 17, 2006

Mail Stop Certificate of Corrections Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Re: U.S. Patent No.: 6,904,672 B2
Issued: June 14, 2005
Inventor: Nagafuku et al.
Our Docket: 34457

Sir:

A Certificate of Correction under 35 U.S.C. 254 is hereby requested to correct Patent Office printing errors in the above-identified patent. Enclosed herewith is a proposed Certificate of Correction (Form No. PTO-1050) for consideration along with appropriate documentation supporting the request for correction.

It is requested that the Certificate of Correction be completed and mailed at an early date to the undersigned attorney of record. The proposed corrections are obvious ones and do not in any way change the sense of the application.

We understand that a check is not required since the errors were on the part of the Patent and Trademark Office in printing the patent.

Very truly yours,

Jeffrey J. Sopko, Reg. No. 27676

JJS:vln
Enclosures

JAN 24 2006

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Mail Stop Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date indicated below.

Jeffrey J. Sopko
Name of Attorney for Applicant(s)

January 17, 2006
Date

Signature of Attorney

PTO/SB/44 (07-03)
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,904,672 B2
DATED : June 14, 2005
INVENTOR(S) : Nagafuku et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 13

Line 50, please delete "is".

Column 17

Lines 63 and 64, please delete "O^{L1} (x^1, y^1) and O^{L2} (x^2, y^2)" and insert therefor - - O_{L1} (x_1, y_1) and O_{L2} (x_2, y_2) - -.

Column 18

Line 2, please delete "O^{L1} and O^{L2}" and insert therefor - - O_{L1} and O_{L2} - -.

Line 3, please delete "O^L (x^L, y^L)" and insert therefor - - O_L (X_L, y_L) - -.

Line 6, please delete "O^{C1} (x^3, y^3) and O^{C2} (x^4, y^4)" and insert therefor - - O_{C1} (x_3, y_3) and O_{C2} (x_4, y_4) - -.

Line 9, please delete "O^{C1} and O^{C2}" and insert therefor - - O_{C1} and O_{C2} - -.

Line 10, please delete "O^C (x^C, y^C)" and insert therefor - - O_C (x_C, y_C) - -.

Line 11, please delete "O^L" and insert therefor - - O_L - -.

Line 11, please delete "O^C" and insert therefor - - O_C - -.

Line 14, please delete "O^L and O^C" and insert therefor - - O_L and O_C - -.

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PATENT NO. 6,904,672 B2

No. of additional copies
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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,904,672 B2 PAGE 2 OF 3
DATED : June 14, 2005
INVENTOR(S) : Nagafuku et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 18

Please delete the formula (1) located above line 25 and insert the following formal therefor

- - $\theta = \tan^{-1} \{(y_3 + y_4) / (x_3 - x_4)\}$ - -.

Column 19

Please delete the formula (2) located at line 50 and insert the following formal therefor

- - X-direction correction value = $(\alpha_1 + \alpha_2 + \alpha_3 + \ldots + \alpha_N)/N$ - -.

Please delete the formal (3) located at line 52 and insert the following formal therefor

- - Y-direction correction value = $(\beta_1 + \beta_2 + \beta_3 + \ldots + \beta_N)/N$ - -.

Please delete the formal (4) located at line 54 and insert the following formal therefor

- - θ-direction correction value = $(\theta_1 + \theta_2 + \theta_3 + \ldots + \theta_N)/ N$ - -.3

Column 23

Line 51, before "mount" please delete "s".

Column 24

Line 9, before "rotating" please delete "s".

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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,904,672 B2
DATED : June 14, 2005
INVENTOR(S) : Nagafuku et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 26

Claim 5, line 20, please delete "caste" and insert therefor - - paste - -.

Claim 9, line 66, please delete "caste" and insert therefor - - paste - -.

Column 27

Claim 9, line 2, please delete "taste" and insert therefor - - paste - -.

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table unit 26 for mounting the delivered circuit board 12 thereon to be moved to the lower surface of a printing mask 24, and a printing unit 30 for printing the solder paste by squeegees 28a and 28b above the circuit board 12 positioned on the lower surface of the printing mask 24.

According to the printer 100, the circuit board 12 is delivered in the following manner. More specifically, the circuit board delivering unit 22 receives the circuit board 12 delivered from a stocker or a line and feeds the circuit board 12 to the table unit 26 provided in the printer 100. The table portion 26 positions and fixes the circuit board 12 thus fed, and moves the circuit board 12 to a predetermined position on the lower surface of the printing mask 24 of the printing unit 30. Moreover, when the printing process of the printing unit 30 is completed, the table unit 26 delivers the circuit board 12 from the printing unit 30 to the circuit board delivering portion 22. Then, the circuit board delivering unit 22 takes the circuit board 12 from the table unit 26 and discharges the circuit board 12 to a delivery outlet, which is not shown.

Fig. 6 shows the detailed structure of the table unit 26. The table portion 26 includes a board mounting table 34 capable of fixing the circuit board 12 through a holding member 32 and moving and rotating the circuit board 12 by a motor control in directions of X, Y, Z and θ shown in the drawing, a board recognizing camera 36 for

illuminated by the light source 44 and an image is picked up by the image pick-up camera 46. The image thus picked up is separated into a land portion 126 and a solder paste portion 128 based on a difference in a luminance of each pixel through an image processing and the missed portion of the land which is interposed between the solder paste 16 and the circuit board 12 and of which image is not picked up is reproduced by an interpolating process by using prepared land data registering the shape of the land. For example, it is possible to accurately reproduce a complete shape of the land by precisely detecting the feature of the shape of the land other than the missed portion (an edge component such as a corner portion or a side of which image is picked up) and estimating the position of the feature of the residual shape from the position of the feature of the shape thus detected while carrying out collation with the shape of the land which is registered in the land data.

Next, the position of the center of the land shape thus separated and reproduced is measured (S11). As shown in Fig. 15, center-of-gravity positions O_{L1} (x_1, y_1) and O_{L2} (x_2, y_2) of the lands 14a and 14b of the circuit board 12 are measured by setting, as a reference position, any board mark 130 for alignment which is provided in the diagonal line position of the circuit board 12 (or an individual mark provided for another purpose). A middle point connecting the center-of-gravity positions O_{L1} and O_{L2} are

set to a land center point O_L (x_L, y_L).

Similarly, a solder paste printing position is measured from the separated solder paste portion 128 (S12). As shown in Fig. 16, center-of-gravity positions O_{C1} (x_3, y_3) and O_{C2} (x_4, y_4) of the solder pastes 16a and 16b printed on the circuit board 12 are measured. A middle point connecting the center-of-gravity positions O_{C1} and O_{C2} is set to a solder paste center point O_C (x_C, y_C). Thus, the land center position O_L and the solder paste center position O_C are determined. Therefore, shift amounts α and β in the X and Y directions are obtained from the center positions O_L and O_C (S13).

Next, the shift amounts α and β thus obtained are compared with a predetermined allowable value of a shift(S14). If the shift amounts α and β are equal to or greater than the allowable value of a shift, there is a possibility that the shift might be caused in the direction of rotation as shown in Fig. 17. Therefore, a shift amount θ in the direction of rotation is measured (S15). The shift amount θ is obtained by an equation (1), for example.

$$\theta = \tan^{-1} \{(y_3 + y_4) / (x_3 - x_4)\} \quad (1)$$

If the shift amounts α and β are smaller than the allowable value of a shift, the measurement of the shift amount θ in the direction of rotation is omitted to assume $\theta = 0$. Also in the case in which the amounts α and β are smaller than the allowable value of a shift, the shift

Data 1 : α_1, β_1, θ_1

Data 2 : α_2, β_2, θ_2

Data 3 : α_3, β_3, θ_3

...

Data N : α_N, β_N, θ_N

An X-direction correction value, a Y-direction correction value and a θ -direction correction value are set from the shift amounts by using equations (2) to (4).

$$\text{X-direction correction value} = (\alpha_1 + \alpha_2 + \alpha_3 + \cdots + \alpha_N)/N \quad (2)$$

$$\text{Y-direction correction value} = (\beta_1 + \beta_2 + \beta_3 + \cdots + \beta_N)/N \quad (3)$$

$$\theta\text{-direction correction value} = (\theta_1 + \theta_2 + \theta_3 + \cdots + \theta_N)/N \quad (4)$$

The correction values in the equations (2) to (4) are applied to all the electronic components to be mounted on the circuit board and the mounting is carried out by collectively changing the target mounting position. As compared with the case in which the mounting positions are individually changed for the electronic components, consequently, the amount of a whole calculation process can be reduced and the speed of the mounting operation can be increased.

Next, description will be given to a third embodiment of the electronic component mounting method according to the invention.

While the amount of the shift of the solder paste printed on the circuit board from the land is averaged and

component mounting apparatus 300, the mounting data can be created. Therefore, a workability for data creation can be enhanced and the operating efficiency of producing equipment can be increased.

Moreover, while the electronic component mounting apparatus 300 has such a structure that the circuit board to mount the electronic component thereon is fixed and a transfer head provided with an attachment head is moved over the circuit board to carry out the mounting operation, the invention is not restricted thereto but the electronic component mounting method according to the invention can be similarly applied to an electronic component mounting apparatus including a rotary head as shown in Figs. 26 and 27, for example.

Fig. 26 is a view showing the appearance of the electronic component mounting apparatus including the rotary head and Fig. 27 is a schematic sectional view showing the rotary head for illustrating the operation of the rotary head. An electronic component mounting apparatus 400 mainly has a component feeding portion 150 for continuously feeding an electronic component, a rotary head 152 for holding the electronic component in the predetermined component feeding position of the component feeding unit 150 and for mounting the electronic component on the circuit board, and an X-Y table 154 for positioning the circuit board. Consequently, the circuit board fed

from a board delivery-in portion 156 is mounted on the X-Y table 154 and the electronic component sent from the component feeding unit 150 is held by the rotary head 152, and a proper correcting process is then carried out to mount the electronic component on the circuit board. The circuit board having the component mounted thereon is delivered from the X-Y table 154 to a board delivery-out portion 158.

In a compartment feeding unit 10, a plurality of component feeding members 160 accommodating a large number of electronic components are arranged in a vertical direction on a paper as shown in Fig. 27 and a compartment feeding member 160 is moved in the direction of the arrangement, thereby feeding a desirable electronic component to a component feeding position.

The X-Y table 154 is provided movably between the board delivery-in unit 156 and the board delivery-out unit 158, is moved to a position to be connected to the board delivery path of the board delivery-in unit 156 to receive the circuit board which has not attached the component, and fixes the circuit board and is moved to the component mounting position of the rotary head 152. Then, the movement of the circuit board 12 corresponding to the mounting position of each electronic component is repeated. When the attachment of the component is completed, the XY table 154 is moved to a position to be connected to the

board delivery-out unit 158 and feeds the circuit board 12 to the board delivery-out unit 158.

The rotary head 152 includes a plurality of attachment heads 162 for sucking an electronic component, a rotating frame member 164 to be rotated by supporting the attachment head 162 on a peripheral surface vertically movably, and an intermittent rotating device 168 for index rotating the rotating frame member 164.

An attachment head 262 is continuously rotated and moved from the component feeding position of the component feeding unit 150 to a component attachment position on the opposite side thereof by the rotation of the rotating frame member 164, falls down in the component feeding position of the component feeding unit 150 to adsorb the electronic component, and recognizes the sucking attitude of the electronic component in a certain component recognition position of the component recognizing device to fall down in the component attachment position, thereby attaching the electronic component onto the circuit board 12.

The electronic component mounting method according to the embodiment can also be applied to the electronic component mounting apparatus 400 including such a rotary head and the same effects can be obtained.

Description will be given to the result of a difference in a self-alignment effect based on a difference between the mounting position of an electronic component

Issued as claim 5

Claim 8 (currently amended): An electronic component mounting method for mounting an electronic component ~~The electronic component mounting method according to claim 1, further~~ comprising the steps of:

providing a circuit board further comprising a land;

printing a solder paste on the land;

detecting a printing position of the solder paste on the circuit board;

mounting the electronic component on the circuit board by referring to the printing position of the solder paste as a reference;

deciding a self-alignment effect from a shift state between a position of a land corresponding to the electronic component to be mounted and the printing position of the solder paste for the land;

setting a target mounting position of the electronic component by using the printing position of the solder paste as a reference in a case that the self-alignment effect is great; and

setting the target mounting position by using the position of the land as the reference in a case that the self-alignment effect is small.

Claim 9 (currently amended): [An] electronic component mounting [a] method for mounting an electronic component ~~The electronic component mounting method according to claim 1, further~~ comprising the steps of:

providing a circuit board further comprising a land;

printing a solder paste on the land;

detecting a printing position of the solder paste on the circuit board;

mounting the electronic component on the circuit board by referring to the printing position of the solder paste as a reference;

setting a correction value at an optional rate for a shift amount between a position of a land corresponding to the electronic component to be mounted and the printing position of the solder paste for the land; and

changing a target mounting position of the electronic component from the position of the land toward the printing position of the solder paste based on the correction value thus set.

Claim 10 (original): The [electronic component mounting] method according to claim 9,

wherein the correction value is set based on a degree of the self-alignment effect which is determined depending